Lung Cancer Screening: LungRADS™ Update

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Department of Radiology
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Lung Cancer

early stage

late stage
Lung Cancer Screening Essentials

- Shared decision making
- Smoking cessation
- Who to screen & Why
- What to screen with & how to do it
- LungRADS - schema to interpret screening exams & manage screening results
- Multidisciplinary team
Lung Cancer Screening Essentials

- Shared decision making
- Smoking cessation
- Who to screen & Why
- What to screen with & how to do it
- LungRADS - schema to interpret screening exams & manage screening results
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CMS - Lung Cancer CT Screening Coverage


Radiology Imaging Facility Eligibility Criteria:

- Performs LDCT with volumetric CT dose index (CTDlvol) of ≤ 3.0 mGy for standard size patients (defined to be 5’ 7” and approximately 155 pounds) with appropriate reductions in CTDlvol for smaller patients and appropriate increases in CTDlvol for larger patients;

- Utilizes a standardized lung nodule identification, classification and reporting system;

- Makes available smoking cessation interventions for current smokers; and

- Collects and submits data to a CMS-approved registry for each LDCT lung cancer screening performed.
ACR LungRADS™

• To provides a common lexicon & definitions
• To standardizes practice among radiologists for communicating with ordering providers
• To define a positive screen
• To address uncertainty in positive screen management
• To facilitate quality assurance & improvement
• *To be updated as knowledge evolves*
ACR RADS newly formed RADS steering committee
ACR LungRADS 1.0 Released April 2014

- Structured reporting and management tool for lung cancer screening CT interpretation; it will iterate with the evidence
  - Definition of (+) screen, management recommendations
  - How nodules are measured (diameter vs. volume)

- Modeled after the ACR’s 20 year experience with BIRADS, now it’s fifth edition

- [http://www.acr.org/Quality-Safety/Resources/LungRADS](http://www.acr.org/Quality-Safety/Resources/LungRADS)
Why LungRADS for Lung Cancer CT Screening?

• High false positive rate & lack of clarity about how to manage positive screens

• Concerns about over testing, radiation exposure, patient anxiety, invasive procedures & cost

• Overdiagnosis: cancer you can live with vs. die of

• Provide standardize reporting & management; facilitate outcomes tracking
ACR LungRADS™

Fundamental question: What is a positive screen?
National Lung Screening Trial

• Positive screen: nodule $\geq$ 4 mm
  - Independent of nodule consistency (solid vs ground glass)

• Positive screen rates:
  - 27.3% baseline
  - 27.9% T1 screen
  - 16.8% T2 screen

• 20% reduction in lung cancer mortality

• LDCT screened group
  - lung cancer diagnosed in 1.1%
  - 90.4% at least 1 one f/u diagnostic procedure
Size Threshold for a Positive Lung Cancer Screening CT

effect of alternative thresholds for defining a positive result on the rates of positive results and cancer diagnoses
Size Threshold for a Positive Lung Cancer Screening CT

21,136 individuals with baseline CT performed between 2006 and 2010

<table>
<thead>
<tr>
<th>Size</th>
<th>(+) Screen Rate</th>
<th>Work Up Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 5 mm</td>
<td>16.0%</td>
<td></td>
</tr>
<tr>
<td>≥ 6 mm</td>
<td>10.2%</td>
<td>36%</td>
</tr>
<tr>
<td>≥ 7 mm</td>
<td>7.1%</td>
<td>56%</td>
</tr>
<tr>
<td>≥ 8 mm</td>
<td>5.1%</td>
<td>68%</td>
</tr>
<tr>
<td>≥ 9 mm</td>
<td>4.0%</td>
<td>75%</td>
</tr>
</tbody>
</table>

9 month delay in cancer dx 0%, 5%, 5.9%, 6.7%
NLST: Size Threshold for a Positive Lung Cancer Screening CT

- Examined impact of nodule size > 4 mm NLST (+) screen
- 64% of (+) screens (11,598/18141) were ≤ 7 mm nodules
- Going from 5 to 8 mm...
  - Missed or delayed cancer increased: 1.0% to 15.8%
  - False positives reduced: 65.8% to 10.5%

“Raising the nodule size threshold for a (+) screen would substantially reduce false-positive CT screenings and medical resource utilization with a variable impact on screening outcomes.”

Gierada DS, Pinsky P, Nath H, Chiles C, Duan F, Aberle DR. Journal of the National Cancer Institute October 2014
Preinvasive Lesions:

- Atypical adenomatous hyperplasia (AAH)
  - localized small proliferation of atypical Type II pneumocytes and/or Clara cells lining the alveolar walls and respiratory bronchioles

- Adenocarcinoma in situ (AIS)
  - ≤ 3 cm solitary adenocarcinoma with pure lepidic growth
  - complete resection achieves 100% disease-specific survival
• Minimally invasive adenocarcinoma (MIA)
  - ≤ 3 cm with predominantly lepidic pattern & ≤5 mm invasion at the largest dimension
  - Does not invade lymphatics, blood vessels or pleura
  - No necrosis
  - Complete resection achieves nearly 100% disease-specific survival

• Invasive adenocarcinoma
<table>
<thead>
<tr>
<th>Category Descriptor</th>
<th>Category Descriptor</th>
<th>Primary Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Negative</td>
<td>No nodules &amp; definitely benign nodules</td>
<td>1</td>
</tr>
<tr>
<td>Benign Appearance or Behavior</td>
<td>Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth</td>
<td>2</td>
</tr>
<tr>
<td>Probably Benign</td>
<td>Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer</td>
<td>3</td>
</tr>
<tr>
<td>Suspicious</td>
<td>Findings for which additional diagnostic testing and/or tissue sampling is recommended</td>
<td>4A, 4B</td>
</tr>
<tr>
<td>Category Descriptor</td>
<td>Category Descriptor</td>
<td>Primary Category</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>------------------</td>
</tr>
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<td>-</td>
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<tr>
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<td>4A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4B</td>
</tr>
</tbody>
</table>
## ACR LungRADS™

<table>
<thead>
<tr>
<th>Category Descriptor</th>
<th>Category Descriptor</th>
<th>Primary Category</th>
<th>Expected Distribution</th>
<th>Probability of Malignancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete</td>
<td>-</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>No nodules &amp; definitely benign nodules</td>
<td>1</td>
<td>90%</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Benign Appearance or Behavior</td>
<td>Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probably Benign</td>
<td>Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer</td>
<td>3</td>
<td>6%</td>
<td>1-2%</td>
</tr>
<tr>
<td>Suspicious</td>
<td>Findings for which additional diagnostic testing and/or tissue sampling is recommended</td>
<td>4A</td>
<td>2%</td>
<td>5-15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4B</td>
<td>2%</td>
<td>&gt; 15%</td>
</tr>
<tr>
<td>Category Descriptor</td>
<td>Category Descriptor</td>
<td>Primary Category</td>
<td>Management</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------------</td>
<td>-----------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Incomplete</td>
<td>-</td>
<td>0</td>
<td>Additional lung cancer screening CT images and/or comparison to prior chest CT examinations is needed</td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>No nodules &amp; definitely benign nodules</td>
<td>1</td>
<td>Continue annual screening with LDCT in 12 months</td>
<td></td>
</tr>
<tr>
<td>Benign Appearance or Behavior</td>
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<td>2</td>
<td></td>
<td></td>
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<tr>
<td>Probably Benign</td>
<td>Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer</td>
<td>3</td>
<td>6 month LDCT</td>
<td></td>
</tr>
<tr>
<td>Suspicious</td>
<td>Findings for which additional diagnostic testing and/or tissue sampling is recommended</td>
<td>4A</td>
<td>3 month LDCT; PET/CT may be used when there is a ≥ 8 mm solid component</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4B</td>
<td>chest CT with or without contrast, PET/CT and/or tissue sampling depending on the *probability of malignancy and comorbidities. PET/CT may be used when there is a ≥ 8 mm solid component.</td>
<td></td>
</tr>
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</table>
### ACR LungRADS™ 4X: Subsolid Nodules

<table>
<thead>
<tr>
<th>Category Descriptor</th>
<th>Description</th>
<th>Primary Category</th>
<th>Expected Distribution</th>
<th>Probability of Malignancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspicious</td>
<td>Radiologist discretion to upcode categories based on additional findings and nodule features</td>
<td>4X</td>
<td></td>
<td>?</td>
</tr>
<tr>
<td>Suspicious</td>
<td>Findings for which additional diagnostic testing and/or tissue sampling is recommended</td>
<td>4B</td>
<td>2%</td>
<td>&gt; 15%</td>
</tr>
</tbody>
</table>

**Malignancy Rates for Lesions Upgraded to Category 4X**

<table>
<thead>
<tr>
<th>Observer</th>
<th>Total Upgraded to Category 4X</th>
<th>Upgraded from Lung-RADS 3</th>
<th>Upgraded from Lung-RADS 4A</th>
<th>Upgraded from Lung-RADS 4B</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30/58 (52)</td>
<td>8/18 (44)</td>
<td>2/3 (67)</td>
<td>20/37 (54)</td>
</tr>
<tr>
<td>2</td>
<td>42/74 (57)</td>
<td>14/28 (50)</td>
<td>8/12 (67)</td>
<td>20/34 (59)</td>
</tr>
<tr>
<td>3</td>
<td>35/64 (55)</td>
<td>10/19 (53)</td>
<td>6/10 (60)</td>
<td>19/35 (54)</td>
</tr>
<tr>
<td>4</td>
<td>29/55 (53)</td>
<td>9/19 (47)</td>
<td>4/8 (50)</td>
<td>16/28 (57)</td>
</tr>
<tr>
<td>5</td>
<td>42/91 (46)</td>
<td>11/30 (37)</td>
<td>8/12 (67)</td>
<td>23/49 (47)</td>
</tr>
<tr>
<td>6</td>
<td>35/66 (53)</td>
<td>8/19 (42)</td>
<td>7/9 (78)</td>
<td>20/38 (53)</td>
</tr>
<tr>
<td>Average</td>
<td>53 (49, 56)</td>
<td>46 (40, 52)</td>
<td>65 (55, 74)</td>
<td>54 (50, 58)</td>
</tr>
</tbody>
</table>

**Feature**

- Effect on surrounding tissue
- Internal nodule structure
- Border characteristics

4X malignancy rate was 46-57% per observer & substantially higher than malignancy rates of categories 3, 4A & 4B SSNs; Radiology 2016 Chung et al
ACR LungRADS™

• What nodules or other findings get into what categories?
  - Nodule size
    • Baseline or new finding
    • Growth vs. Stability
  - Nodule consistency
    • Solid, part solid, non solid (aka ground glass nodule)
    • Specific benign features (calcification, fat)
Classifying Screen-Detected Lung Nodules

solid

part solid

non solid aka GGO or GGN
## NEGATIVE SCREEN: ACR LungRADS™

<table>
<thead>
<tr>
<th>Category</th>
<th>Category Descriptor</th>
<th>Primary Category</th>
<th>Findings</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>No nodules &amp; definitely benign nodules</td>
<td>1</td>
<td>No lung nodules</td>
<td>Continue annual screening with LDCT in 12 months</td>
</tr>
</tbody>
</table>
| Benign Appearance or Behavior | Nodules with a very low likelihood of becoming a clinically active cancer due to size or lack of growth | 2 | nodule(s) with specific calcifications: complete, central, popcorn, concentric rings and fat containing nodules | solid nodule(s):
  • < 6 mm
  • new < 4 mm
part solid nodule(s):
  • < 6 mm total diameter on baseline screening
non solid nodule(s) (GGN):
  • < 20 mm OR
  • ≥ 20 mm and unchanged or slowly growing Category 3 or 4 nodules unchanged for ≥ 3 months |
LungRADS™ 2: Non solid nodule < 2 cm
<table>
<thead>
<tr>
<th>Category</th>
<th>Category Descriptor</th>
<th>Primary Category</th>
<th>Findings</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probably Benign</td>
<td>Probably benign finding(s) - short term follow up suggested; includes nodules with a low likelihood of becoming a clinically active cancer</td>
<td>3</td>
<td>solid nodule(s):</td>
<td>6 month LDCT</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• ≥ 6 to &lt; 8 mm at baseline OR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• new 4 mm to &lt; 6 mm part solid nodule(s):</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• ≥ 6 mm total diameter with</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Solid component &lt; 6 mm OR</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• New &lt; 6 mm total diameter Non solid nodule(s) (GGN) ≥ 20 mm on baseline CT or new</td>
<td></td>
</tr>
</tbody>
</table>
LungRADS™ 2 to 3: Non solid nodule < 2 cm

Stage 1A adenocarcinoma

Courtesy of Ann Leung
Nonsolid Nodule Becomes Part Solid Nodule

Baseline 17 x 13 mm

2 years

9 years part solid

Yankelevitz D et al. Radiology 2015;277
<table>
<thead>
<tr>
<th>Category</th>
<th>Category Descriptor</th>
<th>Primary Category</th>
<th>Findings</th>
<th>Management</th>
</tr>
</thead>
</table>
| Suspicious | Findings for which additional diagnostic testing and/or tissue sampling is recommended | 4A | solid nodule(s):  
• ≥ 8 to < 15 mm at baseline OR  
• Growing < 8 mm OR  
• New 6 to < 8 mm part solid nodule(s):  
• ≥ 6 mm with solid component ≥ 6 mm to < 8 mm OR  
• With a new or growing < 4 mm solid component | 3 month LDCT; PET/CT may be used when there is a ≥ 8 mm solid component |
| | | 4B | solid nodule(s):  
• ≥ 15 mm OR  
• new or growing and ≥ 8 mm part solid nodule(s) with:  
• a solid component ≥ 8 mm OR  
• a new or growing ≥ 4 mm solid component | chest CT with or without contrast, PET/CT and/or tissue sampling depending on the *probability of malignancy and comorbidities. PET/CT may be used when there is a ≥ 8 mm solid component |
| | | 4X | Category 3 or 4 nodules with additional features or imaging findings that increases the suspicion of malignancy | |
ACR LungRADS™
Performance of Lung-RADS in the National Lung Screening Trial: A Retrospective Assessment

- Reclassified NLST CT screening exams using LungRADS
- 26,722 LDCT arm subjects (26,309 baseline; 48,671 post-baseline)

<table>
<thead>
<tr>
<th></th>
<th>BASELINE Lung RADS (NLST)</th>
<th>POST BASELINE LungRADS (NLST)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPR (1-Specificity)</td>
<td>12.9% (26.6%)</td>
<td>5.3% (27.4%)</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>86.1% (93.8%)</td>
<td>78.6% (94.4%)</td>
</tr>
<tr>
<td>PPV</td>
<td>6.9% (3.8%)</td>
<td>10.9% (2.4%)</td>
</tr>
</tbody>
</table>

Paul F. Pinsky, PhD; David S. Gierada, MD; William Black, MD; Reginald Munden, MD; Hrudaya Nath, MD; Denise Aberle, MD; and Ella Kazerooni, MD Annals of Internal Medicine February 2015
LungRADS™ Category S

- Incidental clinically significant findings in 7.5% of screening CTs
  - Reported to be as high as 14% in a systematic review; varying definition of “clinically significant”
  - Some findings lead to health benefit
  - Some findings require additional testing with no health benefit
  - Types of findings:
    - cardiac
    - COPD
    - vascular (aneurysms)
    - masses (upper abdomen, neck, mediastinal)

- ACR incidental findings guidelines on managing incidental findings (abdomen, thyroid; thoracic in progress); included in ACRSelect™ decision support tool
ACR LungRADS™

• To provides a common lexicon & definitions
• To standardizes practice among radiologists for communicating with ordering providers
• To define a positive screen
• To address uncertainty in positive screen management
• To facilitate quality assurance & improvement
• *To be updated as knowledge evolves*
Lung-RADS: Pushing the Limits

Maria D. Martin, MD
Jeffrey P. Kamne, MD
Lynn S. Broderick, MD
Ella A. Kazerouni, MD, MS
Cristopher A. Meyer, MD

Abbreviations: ACR = American College of Radiology, BI-RADS = Breast Imaging Reporting and Data System, LCS = lung cancer screening, Lung-RADS = Lung CT Screening Reporting and Data System


https://doi.org/10.1148/rg.2017170051

Content Codes: [CH CT HP OL]

1From the Department of Radiology, University of Wisconsin School of Medicine, 600 Highland Ave, Madison, WI 53792-3252 (M.D.M., J.P.K., L.S.B., C.A.M.); and Department of Radiology, University of Michigan Health System, Ann Arbor, Mich (E.A.K.). Recipient of a Certificate of Merit award for an education paper.

In response to the recommendation of the U.S. Preventive Services Task Force and the coverage decision by the Centers for Medicare and Medicaid Services for lung cancer screening (LCS) computed tomography (CT), the American College of Radiology introduced the Lung CT Screening Reporting and Data System (Lung-RADS) in 2014 to standardize the reporting and management of screening-detected lung nodules. As with many first-edition guidelines, questions arise when such reporting systems are used in daily practice. In this article, a collection of 15 LCS-related scenarios are presented that address situations in which the Lung-RADS guidelines are unclear or situations that are not currently addressed in the Lung-RADS guidelines. For these 15 scenarios, the authors of this article provide the reader with recommendations that are based on their collective experiences, with the hope that future versions of Lung-RADS will provide additional guidance, particularly as more data from widespread LCS are collected and analyzed.

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ACR LungRADS™ - Update

**Scenario 1**: New LungRADS category 3 solid lung nodule in a patient who is aging out of the screening program.

**Scenario 2**: Lung mass in a patient with vague symptoms.

**Scenario 3**: Solid suspicious (Lung-RADS category 4B) nodule with very slow growth rate.

**Scenario 4**: Ground-glass nodule that increases in density but remains stable in size.

**Scenario 5**: Ground-glass nodule with slow growth rate.

**Scenario 6**: How to measure and classify a part-solid nodule.

**Scenario 7**: Nodule that decreases in size but increases in attenuation.

**Scenario 8**: Nodule with characteristic features of an intrapulmonary lymph node.

**Scenario 9**: Airway (endotracheal or endobronchial) nodule.

**Scenario 10**: Incidental potentially important finding other than lung cancer detected at low-dose LCS CT.

**Scenario 11**: Reenrolling patients in the LCS CT program after a stable abnormality.

**Scenario 12**: Low-dose LCS CT of a patient with a recent respiratory infection.

**Scenario 13**: Categorization of a cavitary lung nodule or nodules.

**Scenario 14**: Low-dose LCS CT of a patient with a history of a treated lung malignancy.

**Scenario 15**: Low-dose LCS CT of a patient with a treated low-risk non lung malignancy.
Lung cancer screening using low-dose CT scanning reduces lung-cancer-specific and overall mortality in high-risk patients. A significant limitation of lung cancer screening is the false-positive rate. The American College of Radiology Lung Imaging Reporting and Data System (Lung-RADS) was designed to standardize reporting of low-dose lung cancer screening results and to decrease the false-positive rate without significantly compromising sensitivity. Implementing Lung-RADS can also improve cost-effectiveness. However, Lung-RADS has never been studied in a prospective fashion. It also does not have a specific reporting category for patients with isolated hilar and mediastinal adenopathy or pleural effusion in the absence of lung nodules. We report four such cases from our lung cancer screening program. We believe that this is a significant limitation of Lung-RADS and should be revised in its new version.

CHEST 2017; 151(3):539-543

does not have a specific reporting category for patients with isolated hilar and mediastinal adenopathy or pleural effusion in the absence of lung nodules
ACR LungRADS™
Update 1.1
2019
• Define perifissural nodules
• Current:
  - Nodules with features of an intrapulmonary lymph node should be managed by mean diameter and the 0-4 numerical category classification
• Future:
  - Solid nodules with smooth margins, an oval, lentiform or triangular shape, and maximum diameter less than 10 mm (perifissural nodules) should be classified as category 2
A perifissural nodule is a fissure-attached, homogeneous, solid nodule that had smooth margins and an oval, lentiform, or triangular shape [1]. They represent about 20% of nodules detected in lung cancer screening, are invariably benign, and do not require follow-up [1,2,3].

More broadly, smooth or attached NCNs comprised 83% of all indeterminate solid pulmonary nodules detected in the NELSON trial [4]. At 1 year follow-up, no cancer was found in smooth (0/654) or attached (0/503) 5-10 mm nodules. Xu et al concluded that 1 year follow-up is sufficient.

PANCAN & BCCA pooled: probability of lung cancer in perifissural nodules was zero (0 of 571 nodules; one-sided 97.5% CI, 0 to 0.006) [5].

2. de Hoop B et al. Pulmonary perifissural nodules on CT scans: rapid growth is not a predictor of malignancy. Radiology. 2012;265(2):611-6
3. Fleischner revision
4. Xu DM et al. Smooth or attached solid indeterminate nodules detected at baseline CT screening in the NELSON study: cancer risk during 1 year of follow-up. Radiology. 2009;250(1):264-72
5. McWilliams A et al. Probability of Cancer in Pulmonary Nodules Detected on First Screening CT. NEJM2013;369;910-919
LungRADS Update #2 – ’19 – Non Solid Nodules

• Raise the size threshold for pure non solid nodules from 20 mm to 30 mm

• Current: Category 2
  - non solid nodule(s) (GGN):
    • $< 20$ mm OR
    • $\geq 20$ mm and unchanged or slowly growing

• Future: Category 2
  - non solid nodule(s) (GGN):
    • $< 30$ mm OR
    • $\geq 30$ mm and unchanged or slowly growing
LungRADS Update #2 – ’19 – Non Solid Nodules

• Slow-growing & longer volume doubling time than solid nodules

• Mean volume doubling time for growing NSNs

• No growth:
  - 90% did not grow @ long-term follow-up (median 59 mths) Chang et al. Chest 2013;143:172

• Indolent course:

• Management evolved to selective surgery & longer annual follow-up
  - 2017 Fleischner Guideline solitary GGO > 8 mm: CT in 6-12 months to confirm persistence, then every 2 yrs until 5 yrs; if grows or new solid component, consider resection
LungRADS Update #3 – ’19 – 4B Management

• Address management for **new** large nodules

• **Current:** Category 4B Management
  - Chest CT with or without contrast, PET/CT and/or tissue sampling depending on the *probability of malignancy and comorbidities. PET/CT may be used when there is a $\geq 8$ mm solid component. For new large nodules that develop on an annual repeat screening CT

• **Future:** Category 4B Management
  - Chest CT with or without contrast, PET/CT and/or tissue sampling depending on the *probability of malignancy and comorbidities. PET/CT may be used when there is a $\geq 8$ mm solid component. **For new large nodules that develop on an annual repeat screening CT, a 1 month LDCT may be considered**
LungRADS Update #4 – ’19 – Nodule Measurement

• Change in how nodule diameter is measured & recorded
• Current:
  - Report average diameter (of long and short axis diameters) rounded to the nearest whole number
• Future:
  - To calculate nodule mean diameter, measure both the long and short axis to one decimal point, and report mean nodule diameter to one decimal point
• Change in how diameter is measured & recorded
• Change in nodule size represents a combination of true change plus measurement error.
• Using average diameter measurements, in order to overcome measurement error and confirm true change, growth of at least 1.5 mm is required. If using volumetric techniques, true change can be determined using the QIBA Lung Nodule Profile Calculator (v0.1) [http://services.accumetra.com/NoduleCalculator.html](http://services.accumetra.com/NoduleCalculator.html)
Will add volume measurements next to diameter measurements

Facilitates future movement to more accurate and comparable 3D volume measurements over time
Size & growth defined in mm to volume

- Current: Mean diameter
- **Future: Volumetric**; new QIBA small nodule profile and growth profile to aid in measuring system performance and the variance around size measurements

- Obstacles:
  - Availability of accurate, robust software tools
  - Fully integrated into radiologist workflow
  - Reimbursement for lung nodule CAD/CAD-like tools which require facility investment & radiologist time to translate
Lung Cancer Screening: LungRADS™ Update

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